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METHOD FOR PRESSURIZING AND HEATING GLASS SUBSTRATE FOR LIQUID CRYSTAL DISPLAY PLATE AND DEVICE THEREFOR

[Abstract]

PURPOSE: To provide a method and device for pressurizing and heating capable of uniformly heating the entire surface of glass substrates and acting the pressurization of these glass substrates as uniformly distributed load as well.

CONSTITUTION: Two sheets one set of the glass substrates 23 which are aligned and temporally fixed are clamped by a pair of flexible sheets 7, 12

having heating elements 8, 13 to generate heat when energized. These glass substrates 23 are held in a hermetic space and the pressure in this space is reduced to bulge the sheets 7, 12 to the mating surface side, by which two sheets of the clamped substrates 23 are pressurized. In addition, the heating elements 8, 13 are energized to heat the sealing material 22 interposed between the glass substrates 23, by which the sealing material is pressurized and cured.

[Claims]

1. A method for pressure-heating a glass substrate for a liquid crystal display device, a method for hardening a sealant interposed between two glass substrates by heating and pressurizing characterized in that a pair of flexible thin plates having a heater which generates heat by being conducted are aligned, a pair of pre-fixed glass substrates are bonded and positioned in a hermetic space, the hermetic space is depressurized thereby to pressurize the two bonded glass substrates as the thin plates are expanded towards facing surfaces thereof, and the sealant between the glass substrates is heated and pressurized to be hardened by conducting the heater.

2. An apparatus for pressurize-heating a glass substrate for a liquid crystal display device characterized in that a flexible thin plate is mounted at a frame, a heater which generates heat by being conducted is installed at an outer surface of an inner surface of the thin plate thereby to form a pair of base plates, one of the base plates is set to be a fixed plate and another base plate is set to be a movable plate facing the fixed plate and moving to widen or narrow an interval of the base plate, and a depressurizing unit for depressurizing a hermetic space formed as the pair of base plates are bonded to each other is mounted.

3. The apparatus of claim 2, wherein the heater is a plane heater that a conductive member is installed on a thin plate formed of an insulating

material.

[Title of the Invention]

METHOD FOR PRESSURIZING AND HEATING GLASS SUBSTRATE FOR LIQUID CRYSTAL DISPLAY PLATE AND DEVICE THEREFOR

[Detailed Description of the Invention]

The present invention relates to an apparatus for pressurizing-heating a glass substrate for a liquid crystal display device and a method thereof, and more particularly, to an apparatus for pressurizing-heating a glass substrate capable of bonding upper and lower glass substrates having a sealant therebetween to each other by performing a mark-alignment and capable of hardening the pre-fixed upper and lower glass substrates by pressurizing the sealant until the two glass substrates has a certain gap therebetween and a method thereof.

[Field of the Invention]

[Description of the Prior Art]

In a liquid crystal display (LCD) device, two glass substrates on which a transparent conductive electrode is coated have a certain gap therebetween by a spacer of several μm, and a liquid crystal is injected into an inner space formed by a sealant thereby bonding the two glass substrates with order by an aligning mark.

A spacer is spread on one of the two glass substrates and a sealant of a thermal resin is mounted at an inner surface of another glass substrate facing the one glass substrate, thereby bonding the upper and lower glass substrates by a bonding device with a mark alignment. Also, the upper and

lower glass substrates are pre-fixed not to be separated from each other. The pre-fixed two glass substrates are pressurized and heated, and the sealant is pressurized until the gap between the two substrates corresponds to a particle diameter of the spacer thereby to be hardened.

In the conventional method, the sealant is hardened by laminating plural pairs of two glass substrates that have been bonded to each other, by setting into a jig by pressurization, and by putting the plural pairs of two substrates into a furnace.

[Problems to be Solved by the Invention]

However, in case of setting the pair of glass substrates into a zig and heating the glass substrates in a furnace, a temperance difference is generated between a center portion and a peripheral portion of the glass substrates and the aligned glass substrates are horizontally moved by a difference of a heat expansion. To prevent this, a heating time and a heating temperature are adjusted. However, in that case, an operation characteristic is lowered and a productivity is lowered.

The sealant between the pre-fixed pair of glass substrates is solved and hardened by heating the glass substrates. Also, at the time of heating the glass substrates, the glass substrates are pressurized so that the gap between the glass substrates can be a certain gap corresponding to the particle diameter of the spacer. However, the pressurization is not uniformly applied on the entire glass substrates thereby to have a difficulty in obtaining a constant gap.

The present invention is to provide a pressurizing-heating apparatus

capable of uniformly pressurizing a glass substrate and uniformly heating an entire surface of the glass substrate

[Means for Solving the Problem]

The present invention relates to a method for hardening a sealant formed of a thermal resin and interposed between two glass substrates by heating and pressurizing, in which a pair of flexible thin plates respectively having a heater which generates heat by being conducted are provided, a pair of pre-fixed glass substrates are aligned and are bonded to each other to be positioned in a hermetic space, the hermetic space is depressurized thereby to pressurize the bonded two glass substrates as the thin plates are expanded towards facing surfaces thereof, and the sealant between the glass substrates is heated and pressurized to be hardened by conducting the heater.

In an apparatus for pressurizing-heating a glass substrate according to the present invention, a flexible thin plate is mounted at a frame, a heater which generates heat by being conducted is installed at an outer surface or an inner surface of the thin plate thereby to form a pair of base plates, one of the base plates is set to be a fixed plate and another base plate is set to be a movable plate facing the fixed plate and moving to widen or narrow an interval of the base plate, and a depressurizing unit for depressurizing a hermetic space formed as the pair of base plates are bonded to each other is mounted. In the apparatus, the heater is a plane heater that a conductive member is installed on a thin plate formed of an insulating material.

The thin plate installed at the frame of the fixed plate and the

movable plate includes a metal thin plate (for example, a stainless thin plate) having a thickness corresponding to 30μm to 200μm, a synthetic resin having a high elasticity (for example, a polycarbonate thin plate), a rubber thin plate, etc. Also, the depressurizing unit for depressurizing the inside of the hermetic space formed as the fixed plate and the movable plate are bonded to each other is formed by forming a hole connected to the inside of the hermetic space at the frame of the fixed plate and by connecting a vacuum pump to the hole. As the heating apparatus according to the present invention, both a vertical type for vertically moving the base plate by supporting the glass substrate in a horizontal direction and a horizontal type for horizontally moving the base plate by supporting the glass substrate in a vertical direction are possible.

A pair of base plates are bonded to each other and a pair of glass substrates are interposed between the thin plates of the two base plates. Then, the inside of the hermetic space where the glass substrate is maintained is depressurized. Accordingly, the flexible thin plates are expanded towards facing surfaces thereof, a uniform load is applied onto the glass substrate, and the sealant interposed between the glass substrates is pressed until it has a certain gap. As the thin plates of the two base plates are depressurized, the thin plates are expanded towards the facing surfaces thereof thereby to have a shape corresponding to a leather of a drum and the base plate serves as a base plate having a buffering function. The glass substrates are pressurized through the buffering function of the base plate, thereby applying a uniform load onto the glass substrate. The load is applied onto the glass substrate only in a

perpendicular direction, thereby having a uniform gap between the two glass substrates.

Hereinafter, a preferred embodiment of the present invention will be explained with reference to the attached drawings. The apparatus for pressurizing-heating a glass substrate A comprises a mechanical frame 1, a fixed plate 2 at an lower portion inside the mechanical frame 1, a movable plate 3 arranged at an upper side of the fixed plate 2, a driving unit 4 for moving the movable plate 3 up and down, and a depressurizing unit 5 for bonding the movable plate 3 that has been lowered up to a certain position to the fixed plate 2, maintaining two pre-fixed glass substrates a and b positioned on the fixed plate 2 in a hermetic space, and depressurizing inside of the hermetic space. The apparatus is entirely constructed as a vertical type.

In the fixed plate 2 fixed at a lower portion inside the mechanical frame 1, a thin plate 7 for opening and closing a passage is fixed to a metal frame 6 having a plane of a spherical ring shape. Also, a heater is attached to a surface of the thin plate 7, an outer edge 6' of the metal frame 6 is protruded more upwardly than a mounting surface of the thin plate 7. Accordingly, a concave portion 9 is formed between the thin plate 7 and the outer edge 6' of the metal frame 6, and a pair of the glass substrates are mounted in the concave portion 9. Also, a hole 10 connected to the inside of the concave portion 9 is installed at the outer edge 6', and an outer passage of the hole 10 is connected to a vacuum pump P of the depressurizing unit 5. Also, an inner passage of the hole 10 is connected to a groove 14 having a ring shape formed to surround the thin plate 7, and the inside of the concave

portion 9 hermetically maintained as the movable plate 3 is bonded to the fixed plate 2 is depressurized thereby to expand the thin plate 7 towards the facing surface thereof. Also, a packing 15 such as an O ring is mounted at a surface of the outer edge 6' so that the hermetic state inside the concave portion 9 can be maintained as the movable plate 3 is bonded to the fixed plate 2.

The thin plate 7 mounted at the metal frame 6 is formed of a stainless material having a thickness corresponding to 30μ~200μ, and is fixed to the metal frame 6 by a welding material or an adhesive material. The heater 8 fixed onto the surface of the thin plate 7 is formed as a plane heater that a conductive member such as a carbon is printed on a thin plate formed of an insulating material such as a ceramic, quartz, synthetic resin, etc. (plate thickness: 100μ~200μ). Accordingly, as power is applied to the conductive member, the heater generates heat.

In the movable plate 3 arranged above the fixed plate 2 and moved up and down in a perpendicular direction, a thin plate 12 for closing a passage of the metal frame 11 having a plane of a spherical ring shape is fixed to the metal frame 11. Also, a heater 13 is attached to a surface of the thin plate 12, an outer edge of the metal frame 11 is formed as a stair shape so as to be bonded to the frame 6 of the fixed plate 2. Also, a ring-shaped groove 16 is formed to surround the thin plate 12 at the metal frame 11 of the movable plate 3, so that a depressurization effect by the vacuum pump is uniformly applied to an outer portion of the glass substrate.

The thin plate 12 mounted at the metal frame 11 is formed of a stainless material having a thickness corresponding to 30μ~200μ, and is

fixed to the metal frame 11 by a welding material or an adhesive material. The heater 13 fixed onto the surface of the thin plate 12 is preferably a plane heater that a conductive member such as a carbon is printed on a thin plate formed of an insulating material such as a ceramic, quartz, synthetic resin, etc. (plate thickness: 100μ~300μ). Accordingly, as power is applied to the conductive member, the heater generates heat. Also, the heater 8 installed at the fixed plate 2 and the heater 13 installed at the movable plate 3 are constructed as a heater that the conductive member is installed on the thin plate of an insulating material so as to uniformly heat the entire surface of the glass substrate.

The driving unit 4 for moving the movable plate 3 up and down comprises a nut member 17 mounted at an upper portion of the mechanical frame 1 to be rotatable in a fixed position, a rod 18 screw-coupled to the nut member 17 and rotated, and a motor 19 for rotating the nut member 17. A rotation of the motor 19 is transmitted to the nut member 17 under a state that a power transmission member such as a chain belt, etc. is positioned therebetween, and thereby the rod 18 screw-coupled to the nut member 17 is moved up and down in an axial direction. Also, a lower portion of the rod 18 is formed to be easily engaged or detached into/from a suspension edge 20 fixed to the surface of the metal frame 11 of the movable plate 3. The nut member 17 and the suspension unit of the rod 18 are installed at each side of the movable plate 3 so as to move the movable plate 3 in a horizontal state.

When the nut member 17 is rotated in a fixed position by driving the motor 19, the stopped rod 18 is moved to the lower side along the axial

direction. Accordingly, the suspended movable plate 3 is bonded to the fixed plate 2 under a state that the suspension edge 20 is positioned therebetween, and the two glass substrates positioned on the heater 8 of the fixed plate 2 is maintained in a hermetic space. In the preferred embodiment, when the movable plate 3 is bonded to the fixed plate 2, the thin plate 12 of the movable plate 3 is in contact with the surface of the glass substrate. However, it is possible to construct that the thin plate 12 of the movable plate 3 is not in contact with the surface of the glass substrate when the movable plate 3 is bonded to the fixed plate 2. When the rod 18 is continuously lowered, the engagement between the rod 18 and the suspension edge 20 is released thereby to freely position the movable plate 3 on the glass substrate and to bond the fixed plate 2 and the movable plate 3 to each other as a hermetic state by the packing 15.

The driving unit 4 for moving the movable plate 3 up and down on the basis of the fixed plate 2 is not limited to the above construction, and another means is possible. Also, it is optional that a heat insulator is installed at an opposite side to the heaters 8 and 13 so that heat generated from the heaters 8 and 13 installed at the fixed plate 2 and the movable plate 3 can be applied onto the glass substrate. In case that the heaters 8 and 13 are fixed to rear portions of the thin plates 7 and 12, the heat insulator is bonded to rear portions of the heaters.

The two sheets of glass substrate 23 supplied to the pressurizing-heating apparatus may be bonded to each other by a bonding device with a mark alignment, and a spacer 21 of several μm is inserted between the glass substrates. Also, a sealant 22 formed of a thermal resin is mounted at a

peripheral portion of the glass substrates, so that the two glass substrates a and b are pressurized to have a gap therebetween corresponding to approximately 15 μm and pre-fixed. Then, the two glass substrates 23 are positioned on the fixed plate 2 of the pressurizing-heating apparatus, and the movable plate 3 is lowered by operating the driving unit 4. The movable plate 3 is bonded to the fixed plate 2, the heater 13 of the movable plate 3 is in contact with the surface of the glass substrate a. Also, the engagement between the rod 18 and the suspension edge 20 is released by operating the driving unit 4, and the movable plate 3 is positioned on the glass substrate a under a free state (Refer to FIGURE 7). Then, the vacuum pump P of the depressurizing unit 5 is operated to depressurize the hermetic inside of the concave portion 9 of the fixed plate 2. Accordingly, the thin plate 7 of the fixed plate 2 and the thin plate 12 of the movable plate 3 pressurize the two glass substrates 23 inserted therebetween by being expanded towards facing surfaces of each thin plate, and the heaters 8 and 13 are conducted. Accordingly, the sealant 22 is pressed up to the diameter of the spacer 21 and is heated to be hardened. Also, the gap between the glass substrates a and b is set to be approximately 5μm (Refer to FIGURE 8). The sealant is heated for approximately 10 minutes in a temperature range corresponding to approximately 140°~180°. Since the fixed plate 2 and the movable plate 3 have a structure that the flexible thin plates are mounted at the ring-shape frame, the glass substrates a and b are pressurized as an elastic body. As the result, a uniform load is applied onto the glass substrates and the sealant 22 is uniformly pressed, thereby maintaining the gap between the glass substrates a and b constantly and thus completing a product of a high

quality. In the present invention, one pressurizing-heating apparatus is installed in a horizontal direction. However, since it takes approximately 10 minutes to heat the sealant, a plurality of pressurizing-heating apparatuses (for example, 10 apparatuses) may be arranged as a ring shape and are alternately operated by a chain, etc. for the enhanced productivity.

[Effect of the Invention]

In the apparatus for pressurizing-heating a glass substrate for a liquid crystal display device according to the present invention, as shown in the claim 1, a uniform load is applied onto the entire glass substrate in a perpendicular direction thereby to uniformly heat the glass substrate. Accordingly, the upper and lower glass substrates are prevented from being mis-aligned thereby to maintain a constant gap therebetween. Also, since the glass substrate is heated by the heater provided at the base plate, a stable heating is performed thereby to reduce the heating time.

Also, since the apparatus is constructed as shown in the claim 2, the unit for pressurizing the glass substrates can be greatly minimized than the existing mechanical unit. Besides, since the heater is constructed as a plane heater as shown in the claim 3, the entire surface of the glass substrate can be uniformly heated thereby to prevent the mis-alignment between the upper and lower glass substrates and thus to perform a stable process.

[Description of Drawings]

FIGURE 1 is a longitudinal front view showing one embodiment of a pressurizing-heating apparatus according to the present invention;

FIGURE 2 is a plane view taken along line 2-2 in FIGURE 1;

FIGURE 3 is an enlarged partial section view showing a movable plate;

FIGURE 4 is an enlarged partial section view showing a fixed plate;

FIGURE 5 is a longitudinal front view showing a state that the movable plate is bonded to the fixed plate;

FIGURE 6 is a plane view showing a surface of a mechanical frame on which a driving unit for moving the movable plate up and down is mounted;

FIGURE 7 is an enlarged partial section view of two bonded base plates; and

FIGURE 8 is a section view showing a state that the glass substrates are pressurized by depressurizing inside of a hermetic space formed as the two base plates are bonded to each other.